Reliability of Reported Maternal Smoking: Comparing the Birth Certificate to Maternal Worksheets and Prenatal and Hospital Medical Records, New York City and Vermont, 2009

Renata E. Howland,
New York City Department of Health and Mental Hygiene, New York, NY, USA

Candace Mulready-Ward,
New York City Department of Health and Mental Hygiene, New York, NY, USA

Ann M. Madsen,
New York City Department of Health and Mental Hygiene, New York, NY, USA

Judith Sackoff,
New York City Department of Health and Mental Hygiene, New York, NY, USA

Michael Nyland-Funke,
Vermont Department of Health, Burlington, VT, USA

Jennifer M. Bombard, and
Division of Reproductive Health, Centers for Disease Control and Prevention, Atlanta, GA, USA

Van T. Tong
Division of Reproductive Health, Centers for Disease Control and Prevention, Atlanta, GA, USA

Renata E. Howland: rroney@health.nyc.gov

Abstract

Maternal smoking is captured on the 2003 US Standard Birth Certificate based on self-reported tobacco use before and during pregnancy collected on post-delivery maternal worksheets. Study objectives were to compare smoking reported on the birth certificate to maternal worksheets and prenatal and hospital medical records. The authors analyzed a sample of New York City (NYC) and Vermont women (n = 1,037) with a live birth from January to August 2009 whose responses to the Pregnancy Risk Assessment Monitoring System survey were linked with birth certificates and abstracted medical records and maternal worksheets. We calculated smoking prevalence and agreement (kappa) between sources overall and by maternal and hospital characteristics. Smoking before and during pregnancy was 13.7 and 10.4 % using birth certificates, 15.2 and 10.7 % using maternal worksheets, 18.1 and 14.1 % using medical records, and 20.5 and 15.0 % using either maternal worksheets or medical records. Birth certificates had "almost perfect" agreement with maternal worksheets for smoking before and during pregnancy ($\kappa = 0.92$ and 0.89) and "substantial" agreement with medical records ($\kappa = 0.70$ and 0.74), with variation by education,

insurance, and parity. Smoking information on NYC and Vermont birth certificates closely agreed with maternal worksheets but was underestimated compared with medical records, with variation by select maternal characteristics. Opportunities exist to improve birth certificate smoking data, such as reducing the stigma of smoking, and improving the collection, transcription, and source of information.

Keywords

Birth certificates; Pregnancy; Reproducibility of results; Smoking; Vital statistics

Introduction

Smoking before and during pregnancy can lead to reduced fertility, poor pregnancy outcomes, and adverse infant health [1]. Estimates of smoking prevalence are critical for guiding policies and evaluating smoking cessation programs. Birth registration systems, operating in 57 state, local, and territorial jurisdictions, are a key population-level source of this information [2]. Birth registration data are based on local adaptations of the US Standard Certificate of Live Birth, recommended by the National Center for Health Statistics (NCHS). Beginning in 1989, NCHS added a question to the birth certificate, capturing prenatal smoking (yes/no) and average daily smoking during pregnancy [3] based on medical records or physician report, or if those sources were unavailable, the mother's report (Fig. 1) [4]. Subsequent studies examining smoking reliability and validity found that the 1989 birth certificate consistently underreported smoking prevalence and had moderate agreement and sensitivity compared with maternal self-report and medical records [5–10]. Factors that may have influenced data quality included perceptions of social stigma, improper provider documentation and record transfer, and variation in hospital data collection and entry procedures [10]. For example, a 1998–1999 survey of New Jersey maternity facilities found that 56 % of hospital staff used prenatal care records to complete smoking information, 30 % used maternal hospital medical records, and 6 % used parent worksheets [11]. The smoking question was also criticized for not assessing changes in smoking behavior during pregnancy [3].

In 2003, NCHS, together with the National Association for Public Health Statistics and Information Systems (NAPHSIS), established new recommendations for birth registration systems to improve data quality, including the type and method of smoking information collected [12]. The revised smoking question captured the daily average cigarettes or packs smoked at four different times—in the 3 months prior to pregnancy and during each trimester (Fig. 1). The smoking question was also added to newly-designed maternal worksheets, which were meant to standardize data collection, specify items that should be collected directly from the mother, and assist hospital staff with data entry to the birth certificate. Though adoption of the 2003 recommendations has been gradual, NCHS estimates that by 2015, all jurisdictions will be using the 2003 birth registration recommendations, including the revised smoking question and worksheets [13].

Only one study to date has examined smoking data quality from the revised 2003 birth certificate. Tong et al. [14] compared birth certificate smoking information with self-reported smoking on the Pregnancy Risk Assessment Monitoring System (PRAMS) survey, which is completed 2–6 months post-delivery either by mail or over the phone. The authors found that the birth certificate captured fewer smokers before and during pregnancy than PRAMS. Smokers who were privately-insured, non-WIC participants, and smoked 5 daily cigarettes were more likely to report smoking on PRAMS than the birth certificate. Although maternal smoking estimates from PRAMS and the revised birth certificate are both based on maternal self-report, the timing, wording, and method of data collection are different and may explain the discrepancy in prevalence. It is also possible that the birth certificate does not accurately reflect the maternal worksheet; however, this has not been examined. Furthermore, no studies have compared smoking information from the 2003 birth certificate with prenatal and hospital medical records, one of the traditional smoking data sources. The objectives of this study are to compare smoking reported on the 2003 birth certificate to that reported on maternal worksheets and medical records (prenatal and hospital delivery), and to combined estimates from maternal worksheets and medical records, in order to see if the combination would pick up the same, or more smokers, than each measure alone. Since we did not consider self-reported smoking on the worksheet or medical record to be the gold standard, we report on reliability, and not validity.

Methods

Sample

The study sample was drawn from New York City (NYC) and Vermont PRAMS respondents who delivered a live-born infant during 5 and 8 month periods, respectively, in 2009. The methodology for PRAMS sampling and data collection has been described in more detail elsewhere [15]. NYC's sample (n = 603) included all PRAMS respondents who delivered in any of the city's 41 maternity hospitals from January 1 to June 4, 2009; Vermont's sample (n = 664) included all PRAMS respondents who delivered in 13 hospitals, (any of the state's 12 hospitals or in one New Hampshire hospital near Vermont's border), from January 1 to August 31, 2009. PRAMS response rates were 67.3 % in NYC and 82.8 % in Vermont during the study period.

As part of a project funded by the Centers for Disease Control and Prevention (CDC), PRAMS survey responses and birth certificate data were linked with data abstracted from medical records (prenatal, hospital delivery, and infant) and state-specific worksheets [16]. CDC selected NYC and Vermont from a pool of applicants currently implementing PRAMS and the 2003 birth certificate. CDC project staff and local PRAMS coordinators trained abstractors in standard data collection methods. Inter-rater reliability was tested by re-abstracting approximately 25 medical records from each site. Among those 25 records, <3.0 % of variables had errors. Project staff reviewed and resolved these errors with abstractors. NYC and Vermont Institutional Review Boards determined the project was exempt from review as each public health agency has the legal authority to review records for surveillance.

We combined NYC and Vermont data to provide a larger sample of smokers. Hospital medical records were located for 100 % of women, but prenatal care records were missing for 3.7 % of women. We excluded women missing maternal worksheets (n = 188, 14.8 %) or tobacco use from the birth certificate or maternal worksheet (n = 44, 3.5 %). Missing maternal worksheets were concentrated in hospitals that did not keep forms for the mandated length of time (3 years), including nine hospitals in NYC and one in Vermont. Women missing maternal worksheets or tobacco use information (n = 232) were more likely to have <12 years education and be non-Hispanic black or Hispanic, unmarried, Medicaid beneficiaries, and WIC participants than those women with complete records. We conducted sensitivity analyses to assess the impact of this missing population on reliability.

Smoking Measures

Smoking status on the 2003 birth certificate is designed to come directly from maternal worksheets, which ask, "How many cigarettes or packs of cigarettes did you smoke on an average day during each of the following time periods? If you never smoked, enter zero for each time period (3 months before pregnancy, first 3 months, second 3 months, and third trimester of pregnancy)". Women who smoked 1 cigarette daily in the 3 months before pregnancy were classified as smoking before pregnancy and women who smoked 1 cigarette daily in either the first or second 3 months, or third trimester of pregnancy as smoking during pregnancy. Medical record abstractors classified women as smokers if there was any indication of smoking before or during any trimester of pregnancy in the prenatal or labor and delivery records, and nonsmokers if so indicated in the records or if no indication of active smoking could be found. Abstractors did not document where in the record information was found. We created an additional "combined" measure of smoking status that classified a woman as a smoker if either the maternal worksheet or medical record indicated any smoking and as a nonsmoker otherwise. Although PRAMS was the sampling base for the study, we did not include any smoking measures from the survey. Since a previous study already exists that provides a comparison between PRAMS and the birth certificate we felt that focusing on the birth certificate, worksheet, and medical record alone would provide the opportunity to go into more depth.

Statistical Analysis

We calculated the percentage of women smoking before and during pregnancy, comparing the birth certificate with the maternal worksheet, medical record, and combined measure. We examined smoking status by maternal characteristics obtained from the birth certificate including age (15–24, 25–34, 35), education (<12, 12, >12 years), race/ethnicity (non-Hispanic white or other), marital status (married or other), timing of entry into prenatal care (first trimester or other), insurance at delivery (Medicaid, private, or other), WIC status (yes, no), parity (0, 1, or 2 prior births), and infant birth weight (< or 2,500 g). We also examined smoking status by hospital characteristics from the birth certificate, including hospital type (private or public), use of an electronic birth registration system (electronic vs. paper), and volume of births (<or median number of births in 2009 in each site). We evaluated differences among categorical variables using Wald Chi Square tests; only statistically significant characteristics are presented.

We calculated the overall percentage of agreement between data sources and Cohen's kappa coefficient (κ), which we classified as slight (0–0.20), fair (0.21–0.40), moderate (0.41–0.60), substantial (0.61–0.80), or almost perfect agreement (0.81–1.0) [17]. To assess significant differences in kappa by maternal and hospital characteristics, we used Wald-Chi Square tests and 95 % confidence intervals (CI). We also examined the number and type of discordant records across sources to assess the degree to which a source underestimated smoking. Since our primary goal was to compare smoking prevalence within this sample, we did not apply PRAMS weights. Thus, our study estimates do not represent NYC or Vermont's entire population of women giving birth. We conducted analyses using SAS 9.2 (Cary, North Carolina).

Results

Our sample included 1037 women, 42.6 % (n = 442) from NYC and 57.4 % (n = 595) from Vermont. Women's mean age at delivery was 29 years (range 15–44). The majority had >12 years of education (62.4 %), were non-Hispanic white (63.2 %), and married (57.3 %). Approximately 79.6 % entered prenatal care in the first trimester and 49.6 % had private insurance. Because NYC and Vermont PRAMS oversamples women with low birth weight infants, 33.8 % of women had an infant <2,500 grams.

Maternal Worksheet Versus Birth Certificate

The prevalence of smoking before and during pregnancy was 15.2 and 10.7 % on the maternal worksheet, compared with 13.7 and 10.4 % on the birth certificate (Table 1). The maternal worksheet captured an additional 18 smokers before pregnancy and 12 smokers during pregnancy that were not recorded on the birth certificate. The birth certificate captured 2 smokers before and 9 smokers during pregnancy that had not been recorded on the maternal worksheet, indicating data collection or entry errors or the use of other data sources. The observed agreement between the birth certificate and maternal worksheet was 98.1 % before and 98.0 % during pregnancy. Agreement was "almost perfect" before pregnancy (κ = 0.92, 95 % CI 0.89, 0.96) and during pregnancy (κ = 0.89, 95 % CI 0.85, 0.94) (Table 1). Agreement did not differ by maternal or hospital characteristics.

Medical Record Versus Birth Certificate

The prevalence of smoking before and during pregnancy was 18.1 and 14.1 % on the medical record, compared with 13.7 and 10.4 % on the birth certificate (Table 2). The medical record captured an additional 65 smokers before and 48 smokers during pregnancy that were not recorded on the birth certificate, while the birth certificate captured 19 smokers before pregnancy and 10 smokers during pregnancy that were not recorded on the medical record. The observed agreement on smoking status between the birth certificate and medical records was 91.9 % before and 94.4 % during pregnancy. Based on Cohen's kappa coefficient, agreement between the birth certificate and medical record was "substantial" for smoking before pregnancy (kappa, κ = 0.70, 95 % CI 0.63, 0.76) and during pregnancy (κ = 0.74, 95 % CI 0.68, 0.80) (Table 2). Agreement for smoking status before pregnancy differed significantly by education, insurance and parity (Table 3). Agreement was lower among women with >12 years (κ = 0.59) compared with <12 years of education (κ = 0.83),

private insurance (κ = 0.46) compared with Medicaid (κ = 0.75), and zero (κ = 0.60) or 1 prior birth (κ = 0.67) compared with 2 births (κ = 0.86). Agreement for smoking during pregnancy did not differ significantly by maternal or hospital characteristics (data not shown).

Combined Estimate Versus Birth Certificate

The combined estimate of smoking before and during pregnancy based on a positive response reported on either the medical record or maternal worksheet was 20.5 and 15.0 %, compared with 13.7 and 10.4 % on the birth certificate (Table 4). Together, the maternal worksheet and medical record captured an additional 72 smokers before pregnancy and 49 smokers during pregnancy. The birth certificate included only one smoker who was not captured by either source. Agreement between the birth certificate and combined estimate was "substantial" for smoking before pregnancy (κ = 0.75, 95 % CI 0.70, 0.81) and during pregnancy (κ = 0.78, 95 % CI 0.73, 0.84). Figure 2 illustrates the gradient of smoking prevalence between sources. Based on differences in relative proportions, smoking before and during pregnancy on the birth certificate was 9.9 and 2.8 % lower than the maternal worksheet, 24.3 and 26.2 % lower than the medical record, and 33.2 and 31.3 % lower than the combined estimate.

Discussion

Our study had several important findings for users of birth certificate smoking data. First, we found that NYC and Vermont birth certificates largely agreed with maternal worksheets, reflecting their intended purpose to aid data entry. However, discrepancies between sources resulted in 2.8 and 9.9 % fewer smokers before and during pregnancy on the birth certificate. These discrepancies were not related to hospital characteristics, but may be driven by individual hospitals or registrars that we were unable to analyze in this study. Second, we found that birth certificates underestimated smoking by 24.3 % before pregnancy and 26.2 % during pregnancy compared to medical records. Moreover, the degree of agreement between birth certificates and medical records varied by maternal characteristics, with poorer agreement among women who were privately insured, had 1 prior birth and had higher educational attainment. Finally, we found that combined smoking estimates from either maternal worksheets or medical records captured even greater numbers of smokers than birth certificates, or each source on its own, suggesting that there are strengths and limitations to each method of smoking ascertainment.

The magnitude and variation in underreporting on the birth certificate presented in this study is similar to results from Tong et al. [14] which showed that the birth certificate underestimated smoking prevalence by roughly 29.1 % before pregnancy and 19.3 % during pregnancy compared with self-reported measures on the PRAMS survey, particularly among women with higher socioeconomic status. Higher levels of perceived smoking stigma, which have been found among those with higher levels of education in a survey of NYC residents, may reduce the likelihood of disclosure at the time of delivery [18]. Lower perceived risk on the part of birth registrars and clinicians may also lead to under ascertainment and underreporting in the medical record. Our findings are also similar to a study of 1993–1995

birth certificates, which found "substantial" agreement for smoking during pregnancy compared with medical records ($\kappa = 0.77$ vs. $\kappa = 0.74$) [6]. Additional smoking validation studies from the 1989 birth certificate use different measures of quality, making it difficult to compare results and determine the impact of revisions to the birth certificate over time [3, 5, 7–9]. Other commonly used information sources of smoking prevalence, such as BRFSS, are weighted to represent the whole population and do not report NYC-specific information; therefore they could not be used for comparison.

Researchers utilizing the birth certificate to study pregnancy outcomes related to smoking should be aware of underreporting and its potential impact on associations. Many have advocated for a broader recognition of both the strengths and limitations of the birth certificate for perinatal and obstetric epidemiology [19, 20]. While other sources of pregnancy smoking data exist, the birth certificate is the only population-based source of smoking data nationwide, providing information on nearly every live birth in the US. Moreover, the birth certificate also allows smoking data to be explored together with other key maternal and infant variables collected. In order to utilize birth certificate data better, studies have recommended applying a standard misclassification rate to all birth certificate data or adjusting estimates specifically among populations known for underreporting [8, 21, 22]. Elaboration of these methods and proper documentation of data limitations, particularly when translated to policy makers and the general public, is important to avoid inaccurate conclusions [7, 23].

Differences in smoking prevalence estimates between the birth certificate and maternal worksheet may be driven by data entry or collection errors. During data collection, hospital staff may supplement or supplant worksheet information with other sources, such as clinician report, medical records, or observed behaviors. Transcription errors between the maternal worksheet and birth registration system could also be driving poor reliability, likely resulting in missed cases, a well-established limitation of single data entry methods [24, 25]. Conversely, systematic data entry errors may be caused by differences in the background, training, and procedures of hospital staff. For example, recent interviews with one hospital found that staff were unaware they should be using the maternal worksheet to collect smoking information [26]. Moreover, in this hospital, mothers were discharged before they completed the maternal worksheet, making it impossible to collect smoking history from them; instead, staff relied entirely on prenatal records or labor and delivery notes. Data collection guidelines or trainings should be implemented to increase knowledge and standardized use of the maternal worksheet. National projects, including the development of a national web-based training for hospital staff and a multi-state data quality committee, are working towards addressing this gap [13].

It is also important to consider which features of the maternal worksheet might affect smoking prevalence on the birth certificate compared with the medical record. For instance, the specificity of the question might contribute to nonresponse, compared with more general questions or categorical responses. Perceptions of the maternal worksheet as a legal document or the presence of the father or other family members might prevent disclosure. It is also possible a partner, family member, or hospital employee could complete the maternal worksheet rather than the mother, without knowledge of her smoking behaviors. Steps to

improve confidentiality during data collection might result in greater disclosure. In one study on self-reported smoking quality during pregnancy, the use of computer-assisted interviewing technology identified 46.1 % more women compared with the birth certificate [27]. Additional studies are needed to determine whether maternal worksheets can more accurately capture maternal cigarette use before and during pregnancy or if other tools are needed.

Finally, our findings suggest that the medical record may be a valuable data source for the birth certificate, capturing more smokers than the maternal worksheet. Currently, medical records are used to collect >40 items for birth registration; however, the format, timing of data collection, and record availability at the time of registration could limit use for smoking ascertainment [28]. The US Public Health Service recommends that all providers assess and document tobacco use during prenatal care visits using a 5-option multiple choice question, which categorizes women as never smoking, quitting prior to or during pregnancy, reducing cigarette intake, or maintaining the same amount [29, 30]. National efforts to 'revitalize' clinical data definitions present in both medical records and the birth certificate are underway, and could be extended to standardize smoking data collection [31]. Training or guidance on abstracting and summarizing data from the medical record to the birth certificate would also be needed. In the future, greater integration between electronic medical records and electronic birth registration systems could facilitate this process by directly capturing and populating the birth certificate. A recent study found that smoking status was available in 90 % of all electronic medical records in a large Minnesota medical group. Furthermore, smoking prevalence among prenatal care patients was 16 %, corresponding with Minnesota PRAMS estimates of third trimester smoking prevalence for the same year (13.6 %) [32, 33]. Electronic medical records may provide more complete and efficient means of smoking data collection for the birth certificate and should be evaluated further.

Several study limitations should be noted. First, our sample of smoking mothers was relatively small, particularly in NYC; thus we were unable to stratify results by location, hospital, or race/ethnicity, rather we focused on aggregate characteristics that might identify system level variation. For NYC, smokers per hospital ranged from 1 to 39; and for Vermont smokers per hospital ranged from 15 to 276. Exploratory analysis of NYC and Vermont specific data showed consistent patterns of smoking reliability among data sources, supporting use of a combined sample. Second, PRAMS oversamples mothers with low birth weight infants (34 % of sample), which could increase the sample smoking prevalence and bias results. However, smoking prevalence based on the birth certificate was similar for mothers with a low birth weight infant (14.2 %) to those mothers with a normal weight infant (13.4 %) and agreement with both the maternal worksheet and medical record did not vary significantly by these subgroups. Because the sampling weights were not applied as designed for PRAMS and the larger CDC-study, our data are not representative of the nation or of the entire NYC and Vermont populations [16]. Third, abstractors did not collect information on the specific data source used (prenatal or hospital record) or smoking by trimester of pregnancy, an important addition to the 2003 birth certificate. Therefore, we were unable to examine differences by these variables. In addition, we may have misclassified smokers by classifying those with 'unknown' behaviors as non-smokers;

however, only 41 records had 'unknown' smoking status, representing 4.0 % of the sample. Finally, the absence of maternal worksheets in roughly 20 % of the sample led to significant differences between our analytical sample and overall sample. We believe these differences were driven by hospital-level variation in record keeping procedures and did not bias results. Sensitivity analyses showed that agreement improved with the inclusion of this missing sample; however, the trends in agreement were consistent, supporting our conclusions.

Conclusion

To monitor progress toward achieving the Healthy People 2020 objective to reduce prenatal smoking and evaluate smoking cessation programs, reliable smoking data are needed [34]. The birth certificate is a valuable data source, capturing information on all US live births. The 2003 revision of the smoking question and addition of the maternal worksheet were designed to improve data quality; however, limited evidence exists evaluating the impact of these changes. Our findings indicate that in NYC and Vermont smoking information from the birth certificate closely matched the maternal worksheet, with some differences. However, the birth certificate underestimated smoking before and during pregnancy compared with medical records. Additional studies are needed to evaluate quality improvement opportunities, such as facilitating worksheet completion by mothers, increasing hospital staff knowledge, and improving data entry. In the future, greater standardization and integration of electronic medical records with birth registration systems could facilitate data collection. Researchers, program staff and policy makers should be aware of the limitations of birth certificate smoking data and consider established methods for adjusting analyses. As data quality improves, future research will be needed to account for changes in the interpretation of trends.

Acknowledgments

References

1. Office on Smoking and Health National Center for Chronic Disease Prevention and Health Promotion Centers for Disease Control and Prevention. [Accessed March 4, 2014] Surgeon general's report: The health consequences of smoking—50 years of progress. 2014. http://www.surgeongeneral.gov/library/reports/50-years-of-progress/50-years-of-progress-by-section.html

2. Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. [Accessed October 11, 2013] Prenatal smoking data book: Data sources and definitions. http://www.cdc.gov/reproductivehealth/prenatalsmkbk/data_sources_definitions.htm

3. Ventura SJ. Using the birth certificate to monitor smoking during pregnancy. Public Health Reports. 1999; 114(1):71–73. [PubMed: 9925174]

4. National Center for Health Statistics, US Department of Health and Human Services. [Accessed February 2014] Hospitals' and physicians' handbook on birth registration and fetal death reporting. http://www.cdc.gov/nchs/data/misc/hb_birth.pdf. Published October 1987

5. Buescher PA, Taylor AK, Davis MH, et al. The quality of the new birth certificate data: A validation study in North Carolina. American Journal of Public Health. 1993; 83(8):1163–1165. [PubMed: 8342728]

6. DiGiuseppe DL, Aron DC, Ranbom L, et al. Reliability of birth certificate data: A multi-hospital comparison to medical records information. Maternal and Child Health Journal. 2002; 6(3):169–179. [PubMed: 12236664]

7. Northam S, Knapp TR. The reliability and validity of birth certificates. Journal of Obstetric, Gynecologic, and Neonatal Nursing. 2006; 35(1):3–12.10.1111/j.1552-6909.2006.00016.x

8. Allen AM, Dietz PM, Tong VT, et al. Prenatal smoking prevalence ascertained from two population-based data sources: birth certificates and PRAMS questionnaires. Public Health Reports. 2008; 123(5):586–592. [PubMed: 18828413]

9. Piper JM, Mitchel EF, Snowden M, et al. Validation of 1989 Tennessee birth certificates using maternal and newborn hospital records. American Journal of Epidemiology. 1993; 137(7):758–768. [PubMed: 8484367]

10. Dietz PM, Adams MM, Kendrick JS, et al. Completeness of ascertainment of prenatal smoking using birth certificates and confidential questionnaires: Variations by maternal attributes and infant birth weight. PRAMS Working Group. Pregnancy Risk Assessment Monitoring System. American Journal of Epidemiology. 1998; 148(11):1048–1054. [PubMed: 9850126]

11. Smulian JC, Ananth CV, Hanley ML, et al. New Jersey's electronic birth certificate program: Variations in data sources. American Journal of Public Health. 2001; 91(5):814–816. [PubMed: 11347590]

12. National Center for Health Statistics, US Department of Health and Human Services. [Assessed January 24, 2014] The new birth certificate: Making vital statistics more vital (power point presentation). http://www.cdc.gov/nchs/nvss/vital_certificate_revisions.htm

13. Martin JA, Wilson EG, Osterman JK, et al. Assessing the quality of medical and health data from the 2003 birth certificate revision: Results from two states. National Vital Statistics Reports. 2013; 62(2):1–20. http://www.cdc.gov/nchs/data/nvsr/nvsr62/nvsr62_02.pdf.

14. Tong VT, Dietz PM, Farr SL, et al. Estimates of smoking before and during pregnancy, and smoking cessation during pregnancy: Comparing two population-based data sources. Public Health Reports. 2013; 128(3):179–188. [PubMed: 23633733]

15. Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention. . [Accessed October 15, 2013] PRAMS methodology. http://www.cdc.gov/prams/methodology.htm

16. Dietz PM, Bombard JM, Mulready-Ward C, et al. Validation of selected items on the 2003 US Standard Certificate of Live Birth: New York City and Vermont. Public Health Reports. 2015; 1:60–70. [PubMed: 25552756]

17. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977; 33(1):159–174. [PubMed: 843571]

18. Stuber J, Galea S, Link BG. Smoking and the emergence of stigmatized social status. Social Science and Medicine. 2008; 67:420–430. [PubMed: 18486291]

19. Kirby RS. Using vital statistics databases for perinatal epidemiology: Does the quality go in before the name goes on? American Journal of Epidemiology. 2001; 154(10):889–891. [PubMed: 11700241]

20. Schoendorf KC, Branum AM. The use of United States vital statistics in perinatal and obstetric research. American Journal of Obstetrics and Gynecology. 2006; 194(91):1–5. [PubMed: 16389003]

21. MacLehose RF, Olshan AF, Herring AH, et al. Bayesian methods for correcting misclassification: An example from birth defects epidemiology. Epidemiology. 2009; 20(1):27–35.10.1097/EDE. 0b013e31818ab3b0 [PubMed: 19234399]

22. Land TG, Landau AS, Manning SE, et al. Who underreports smoking on birth records: A Monte Carlo predictive model with validation. PLoS One. 2012; 7(4):e34853.10.1371/journal.pone. 0034853 [PubMed: 22545091]

23. Russell TV, Crawford MA, Woodby LL. Measurements for active cigarette smoke expsoure in prevalence of cessation studies: Why simply asking pregnant women isn't enough. Nicotine & Tobacco Research. 2004; 6(2):S141–S151. [PubMed: 15203817]

24. Hong MK, Yao HH, Pedersen JS, et al. Error rates in a clinical data repository: Lessons from the transition to electronic data transfer–a descriptive study. BMJ Open. 201310.1136/bmjopen-2012-002406

25. Wahi MM, Parks DV, Skeate RC, et al. Reducing errors from the electronic transcription of data collected on paper forms: A research data case study. Journal of the American Medical Informatics Association. 2008; 15(3):386–389.10.1197/jamia.M2381 [PubMed: 18308994]

26. Wilson, S. [Accessed November 18, 2013] Exploring the 2003 revision of the US Standard Certificate of Live Births: Results of cognitive interviews conducted in state one of four. 2009. http://www.cdc.gov/QBANK/report/Willson_NCHS_2008_Birth%20Certificate%201.pdf

27. Srisukhumbowornchai S, Krikov S, Feldkamp ML. Self-reported maternal smoking during pregnancy by source in Utah, 2003–2007. Birth Defects Research, Part A: Clinical and Molecular Teratology. 2012; 94(12):996–1003.10.1002/bdra.23058

28. National Center for Health Care Statistics. US Department of Health and Human Services. [Accessed April 22, 2014] Guide to completing the facility worksheets for the certificate of live birth and report of fetal death (2003 revision). http://www.cdc.gov/nchs/data/dvs/guidetocompletefacilitywks.pdf. Published March 2003. Updated March 2012

29. American College of Obstetricians and Gynecologists. Committee opinion no. 471: Smoking cessation during pregnancy. Obstetrics and Gynecology. 2010; 116(5):1241–1244.10.1097/AOG.0b013e3182004fcd [PubMed: 20966731]

30. U.S. Preventative Services. Counseling and interventions to prevent tobacco use and tobacco-caused disease in adults and pregnant women: U.S. Preventive Services Task Force reaffirmation recommendation statement. Annals of Internal Medicine. 2009; 150(8):551–555. [PubMed: 19380855]

31. The American Congress of Obstetricians and Gynecologists. [Accessed May 5, 2013] ReVITALize obstretic data defintions. http://www.acog.org/revitalize

32. Solberg LI, Flottemesch TJ, Foldes SS, et al. Tobacco-use prevalence in special populations taking advantage of electronic medical records. American Journal of Preventive Medicine. 2008; 35(6 Suppl):S501–S507.10.1016/j.amepre.2008.08.033 [PubMed: 19012845]

33. Tong VT, Dietz PM, Morrow B, et al. Trends in smoking before, during, and after pregnancy—Pregnancy Risk Assessment Monitoring System, United States, 40 Sites, 2000–2010. MMWR. 2013; 62(SS02):1–19. [PubMed: 24196750]

34. Office of Disease Prevention and Health Promotion U.S. Department of Health Human Services. [Accessed January 24, 2014] Healthy people. 2020. http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=41Updated August 28, 2013

1989 US Standard Certificate of Live Birth

Tobacco use during pregnancy? . . . . Yes ☐   No ☐

Average number of cigarettes per day _____

2003 US Standard Maternal Worksheet for the Child's Certificate of Live Birth

37. CIGARETTE SMOKING BEFORE AND DURING PREGNANCY
For each time period, enter either the number of cigarettes or the number of packs of cigarettes smoked. IF NONE, ENTER "0".

Average number of cigarettes or packs of cigarettes smoked per day.

	# of cigarettes		# of packs
Three Months Before Pregnancy	_____	OR	_____
First Three Months of Pregnancy	_____	OR	_____
Second Three Months of Pregnancy	_____	OR	_____
Third Trimester of Pregnancy	_____	OR	_____

Fig. 1.
Smoking question on the 1989 US standard certificate of live birth and the revised 2003 US standard certificate of live birth
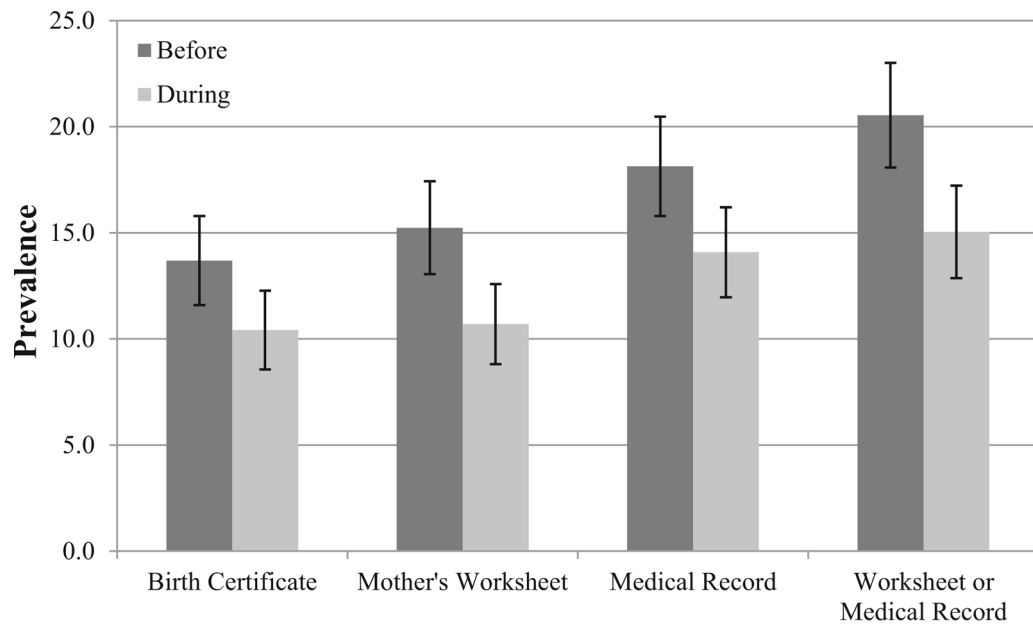
Fig. 2.
Prevalence estimates and 95 % confidence intervals of smoking before and during pregnancy on the birth certificate, maternal worksheet, medical record, and combined estimate (worksheet or medical record) in NYC and Vermont, 2009

Table 1

Prevalence and agreement of smoking before and during pregnancy on the birth certificate and worksheet in NYC and Vermont, 2009[a]

	Smoking before pregnancy[a]				Smoking during pregnancy[a]		
BC	Worksheet			BC	Worksheet		
	Y	N			Y	N	
Y	140	2	142	Y	99	9	108
N	18	877	895	N	12	917	929
	158	879	1037		111	926	1037
BC	13.7 %			BC	10.4 %		
Worksheet	15.2 %			Worksheet	10.7 %		
Agreement	98.1 %			Agreement	98.0 %		
Kappa (κ)	0.92			Kappa (κ)	0.89		
CI	0.89, 0.96			CI	0.85, 0.94		

BC birth certificate, *CI* confidence interval

[a] All estimates are unweighted

Table 2

Prevalence and agreement of smoking before and during pregnancy on the birth certificate and medical record in NYC and Vermont, 2009

Smoking before pregnancy[a]			**Smoking during pregnancy[a]**		
BC	**Worksheet**		**BC**	**Medical Record**	
	Yes	**No**		**Yes**	**No**
Yes	123	19	142	Yes	98	10	108
No	65	830	895	No	48	881	929
	188	849	1037		146	891	1037
BC	13.7 %			BC	10.4 %	
Worksheet	18.1 %			Worksheet	14.1 %	
Agreement	91.9 %			Agreement	94.4 %	
Kappa (κ)	0.70			Kappa (κ)	0.74	
CI	0.63, 0.76			CI	0.68, 0.80	

BC birth certificate, *CI* confidence interval

[a] All estimates are unweighted

Table 3

Prevalence and agreement of smoking before pregnancy on the birth certificate and medical record by select maternal and infant characteristics in NYC and Vermont, 2009

	n	Smoking before pregnancy[a]					
		Birth certificate	Medical record	Agreement			
		%	%	κ	95 % CI	*p*-value	
Overall	1,037	13.7	18.1	0.70	0.64, 0.76		
Select characteristics[b]							
Education						0.010	
< 12 years	133	21.1	24.1	0.83	0.71, 0.94		
12 years	254	25.2	29.5	0.73	0.64, 0.83		
> 12 years	647	7.7	12.4	0.59	0.49, 0.70		
Insurance						0.002	
Medicaid	496	23.6	27.2	0.75	0.68, 0.81		
Private	514	3.9	8.9	0.46	0.30, 0.60		
Other	21	23.8	33.3	0.73	0.47, 1.00		
Parity						0.001	
0 prior births	524	13.0	18.7	0.67	0.59, 0.76		
1 prior birth	300	11.7	16.0	0.60	0.46, 0.73		
2 births	211	13.7	19.9	0.86	0.78, 0.95		

κ kappa, *CI* confidence interval

[a] All estimates are unweighted

[b] We also examined maternal age, race/ethnicity, marital status, first trimester prenatal care, WIC participation, and low birth weight infant; however, these characteristics were not significant and results were not shown

Table 4

Prevalence and agreement of smoking before and during pregnancy on the birth certificate and combined estimate (worksheet or medical record) in NYC and Vermont, 2009

	Smoking before pregnancy[a]				Smoking during pregnancy[a]		
BC	**Combined**			**BC**	**Combined**		
	Y	**N**	**N**		**Y**	**N**	**N**
Y	141	1	142	Y	107	1	108
N	72	823	895	N	49	880	929
	213	824	1037		156	881	1037
BC	13.7 %			BC	10.4 %		
Worksheet	20.5 %			Worksheet	15.0 %		
Agreement	93.0 %			Agreement	95.2 %		
Kappa (κ)	0.75			Kappa (κ)	0.78		
CI	0.70, 0.81			CI	0.73, 0.84		

BC birth certificate, *CI* confidence interval

[a] All estimates are unweighted